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Sandia National Laboratories

Flight Test - Session 12

Development of a H₂O₂ Guidance Thruster for Target Applications

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Albuquerque, NM.

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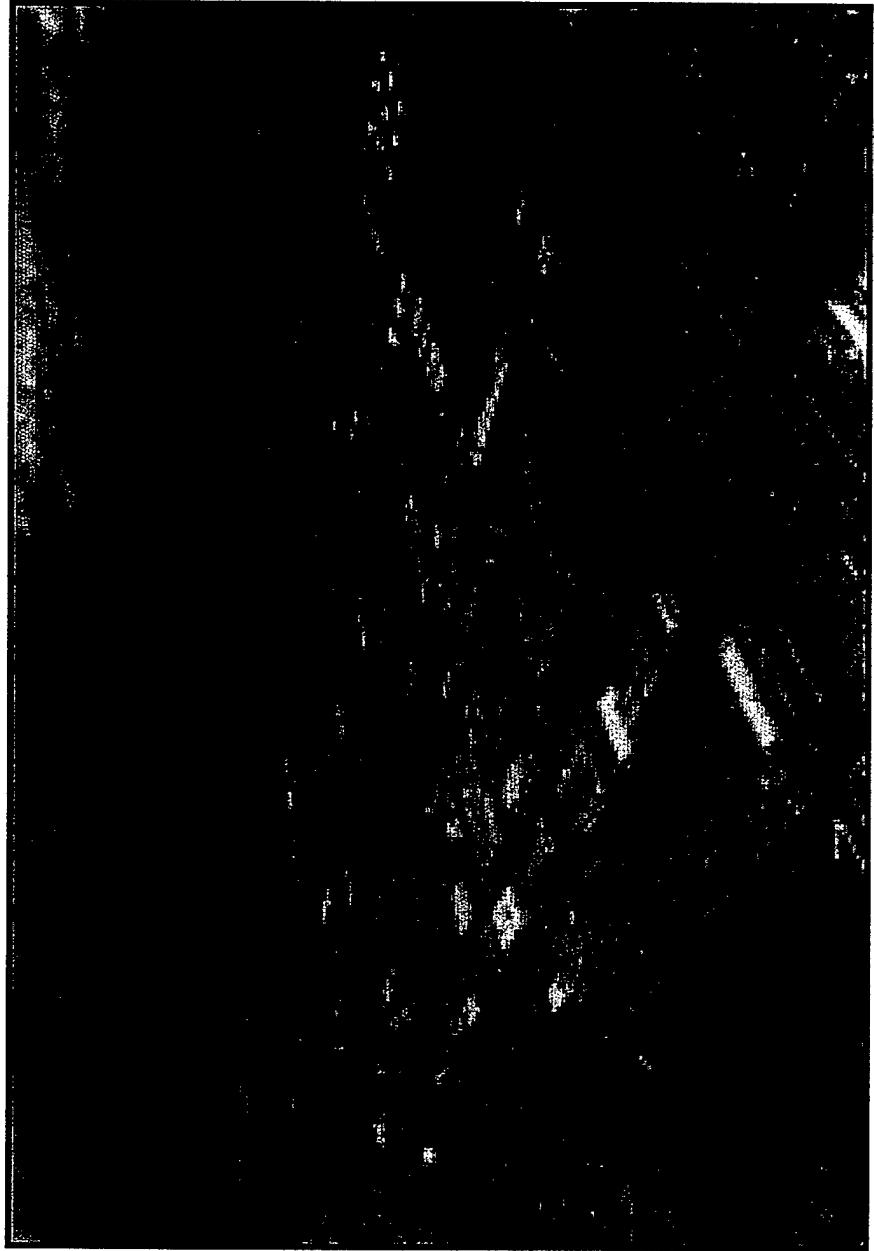




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Sandia National Laboratories

Sandia is government-owned, contractor-operated multi-disciplinary laboratory. Federal funding and direction are provided by the U.S. Department of Energy. The main site is co-located with Kirtland AFB in Albuquerque, New Mexico.



Over 7500 full-time staff are employed at Sandia with approximately 75% of the scientists and engineers holding advanced degrees in their technical disciplines.

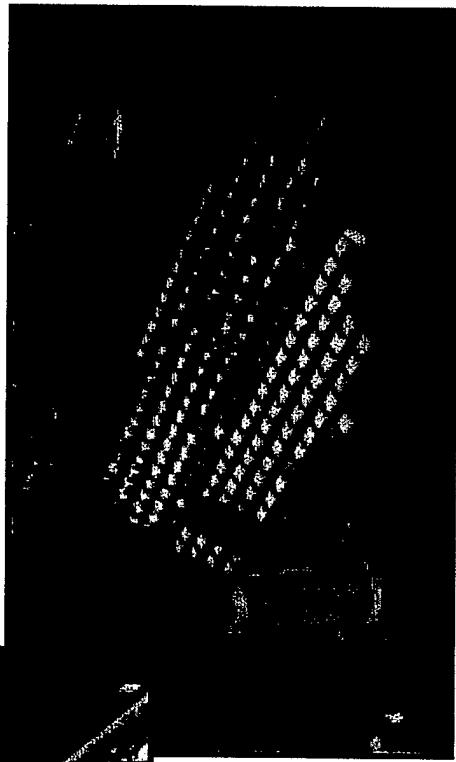
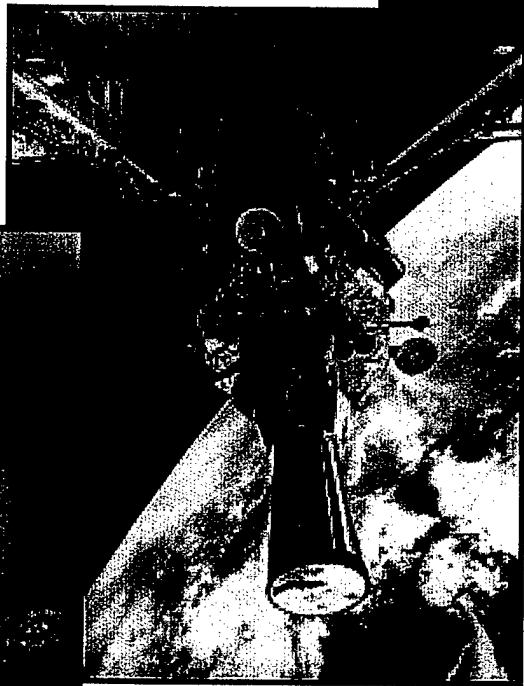
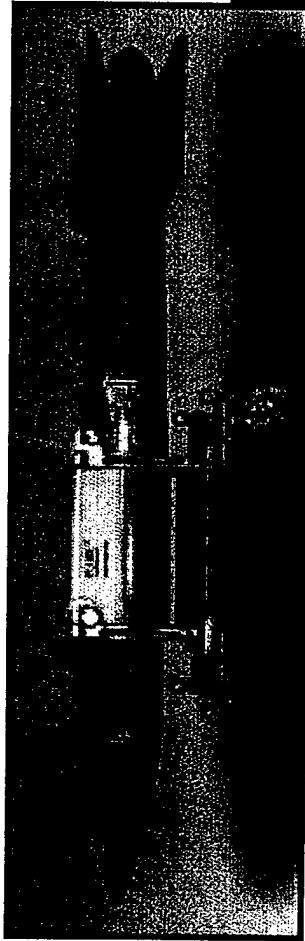
An extensive number of facilities are available to design, fabricate and test aerospace components and systems

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Exceptional Service in the National Interest

Sandia's primary mission is stewardship of the nation's nuclear weapons stockpile.



Sandia also executes work for other federal agencies and industry when it is complementary to our primary mission and it is in the nation's interest.

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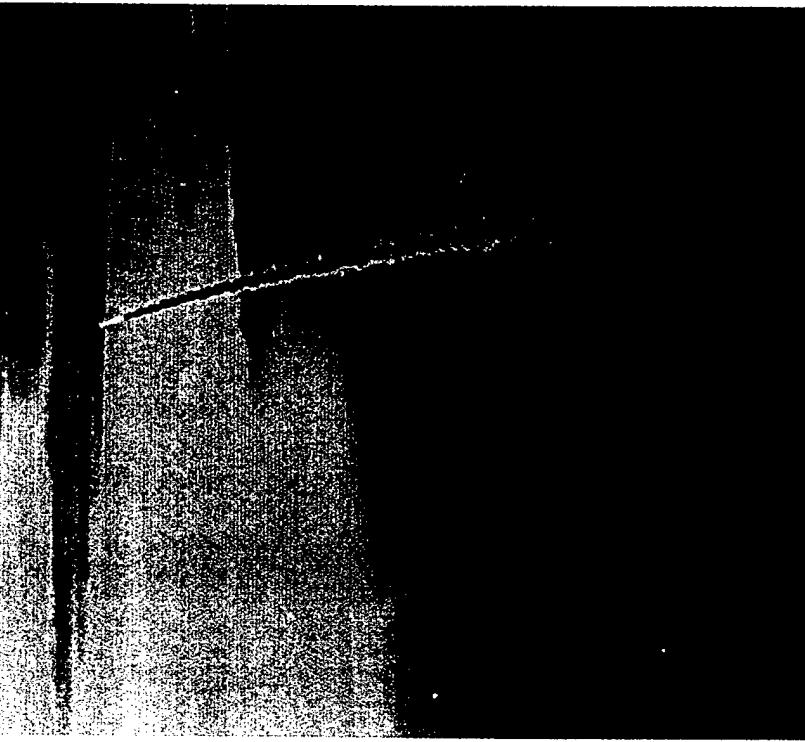
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Aerospace Systems Development Center

Special capabilities

- Pre-prototyping
- Hypersonic vehicles
- Reentry systems
- ICBM payloads
- Sounding rockets/STARS
- Advanced munitions
- Special projects
- Rehabilitation Engr & Assistive Technology

SNL Payload on Minuteman, launched from VAFB



Expertise

- Systems Integration
- Mission planning
- Mechanical/electrical design
- One-of-a-kind fabrication
- Flight qualification
- Telemetry & instrumentation
- Field operations
- Data collection, reduction & analysis

Customers

BMDO, USASMDC, NASA, DARPA, DTRA,
USAF/AFRL, USN/SSPO, SNL/DP, NIH, VA

- Develop & integrate advanced aerospace systems



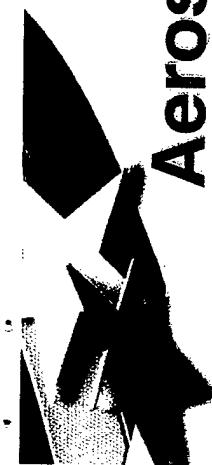
- Respond promptly to customers needs



- Execute full-scale, high risk technology demonstrations

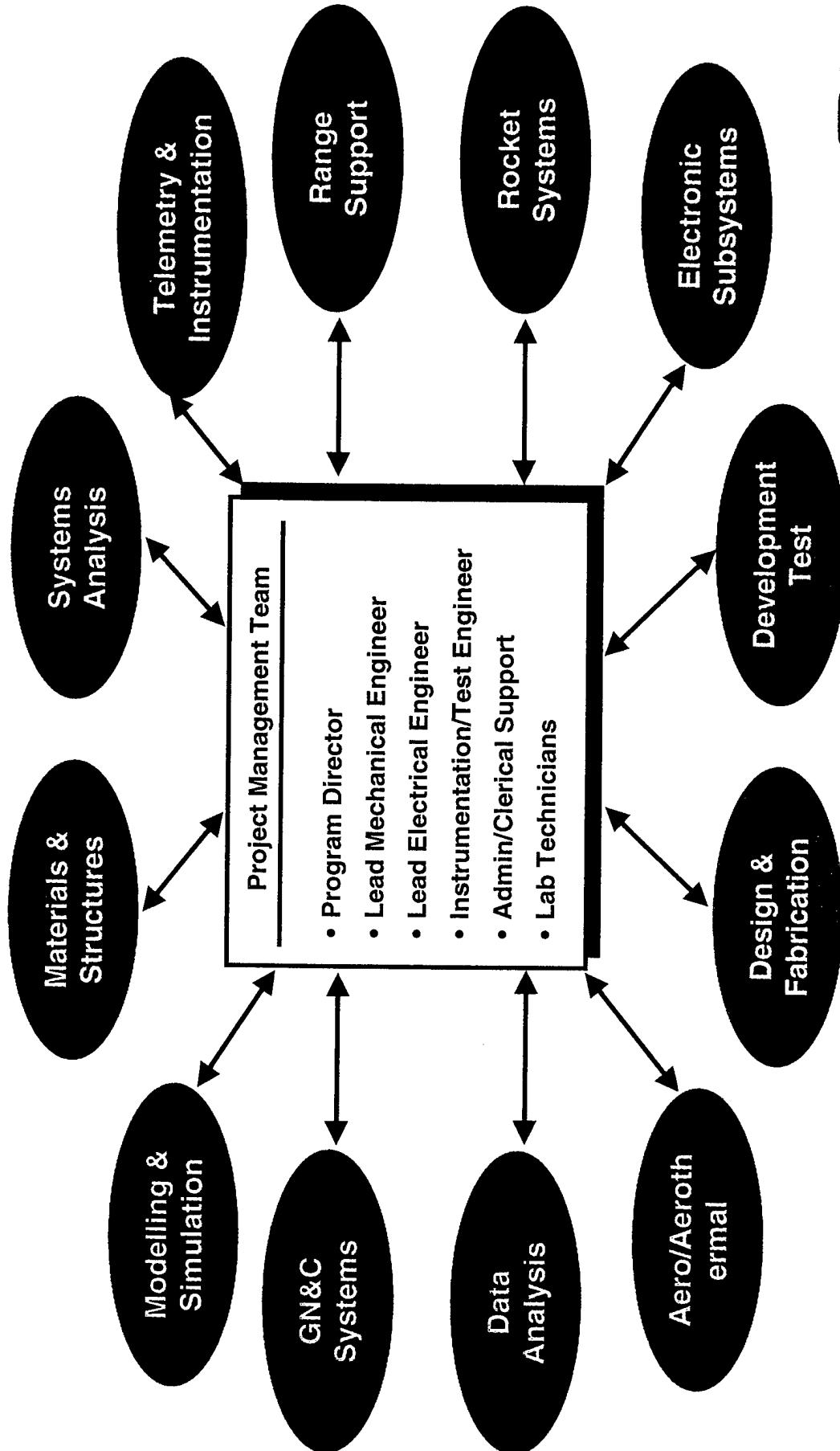
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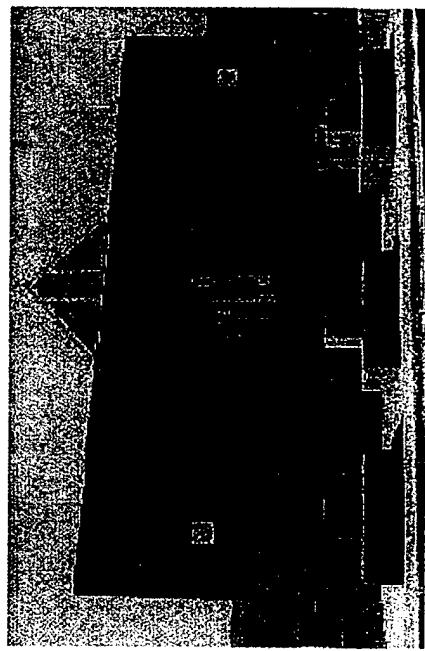
Aerospace Systems Engineering Capability



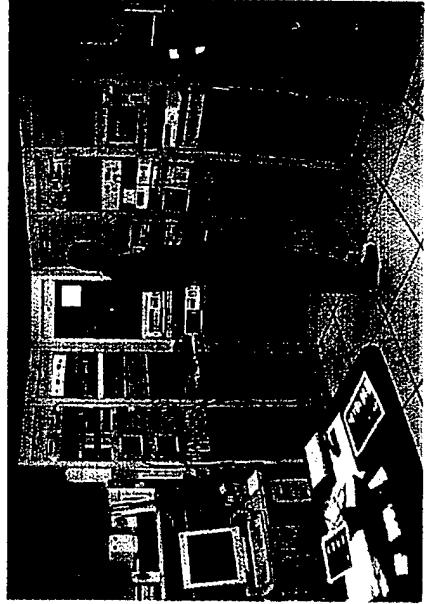
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Energetic Materials Research



Main Laboratory



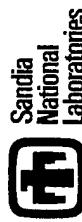
Control Room



Test Cell

Sandia has the highly skilled staff and a state-of-the-art facility required to successfully conduct research, development and testing of energetic materials. For more information, visit our web site at <http://www.sandia.gov/explosive>.

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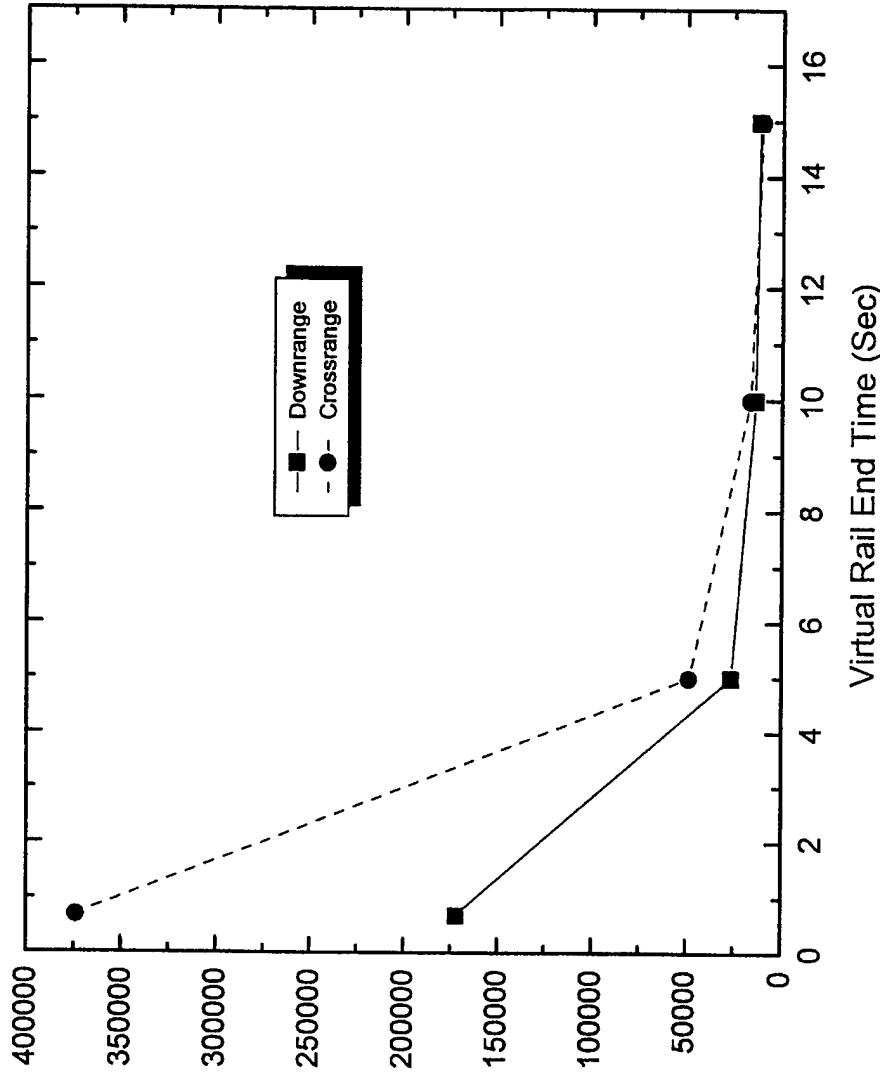
Virtual Rail Concept

Initiated Sandia Interest in H₂O₂

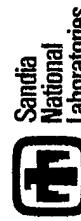
Virtual Rail Concept
- Dispersion reduction by
controlling vehicle attitude
after end of actual rail
length

- Vehicle attitude controlled
by combination of Sandia's
spinning NG&C approach
and Hydrogen Peroxide
engines

- Initial analyses indicate that
75-85% of dispersion can
be eliminated through
effective control during
first 10 seconds of flight

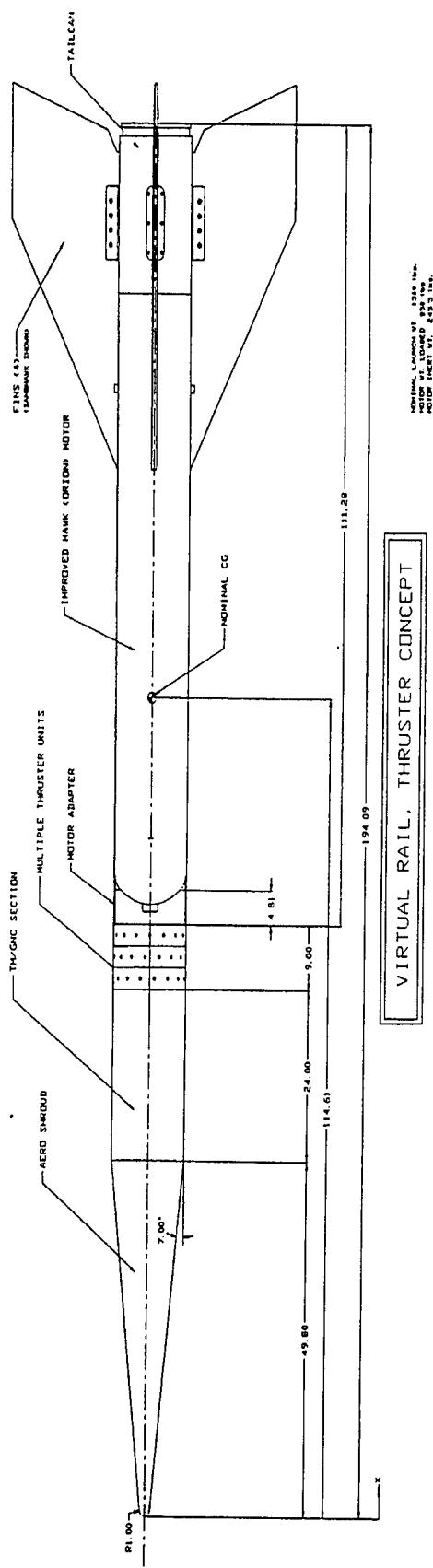


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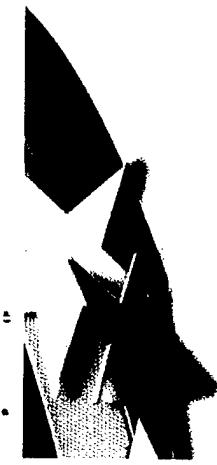
Virtual Rail System Concept



Rocket engines fire as the flight system spins to produce a controlling moment to reduce dispersions.

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Hydrogen Peroxide

Why Use It?

- Long history
- Flexible use (monopropellant, oxidizer)
- Good density impulse
- Low (adjustable) combustion temperature
- “Non” toxic, Non-carcinogenic
- Clean exhaust (environmentally friendly, hardware friendly)

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Hydrogen Peroxide

What is it?

- $\text{H}_2\text{O}_2 \rightarrow \text{H}_2\text{O} + \frac{1}{2}\text{O}_2 + \text{Energy}$
 - 3% pharmaceutical
 - 31% semiconductor
 - 50% waste-water
 - 60% Oxidizer/IC engine
 - 70% Oxidizer/monopropellant rocket engine
 - 90+% propulsion grade

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Hydrogen Peroxide

The Re-discovered Propellant

- **History**

- Reported 1818 by Thenard (government-subsidized research)
- 1933 Torpedo propulsion, US Navy
- 1934 60% used for underwater propulsion, Germany (type 26 boat, 900tons displacement, 90 tons Hydrogen Peroxide, 24k, 6hr, 7500hp) V-1, V-2, Me 163, RATO units
- 1952/3 Sprite, Super Sprite Dehavilland Engine Co., England
- 1954 225 ft “Explorer”, Great Britain (nicknamed the “Exploder”)
- Redstone, Mercury, Scout,...LLS, SYNCOM, COMSAT, X-15...?1970 to present Hydrazine takes over...



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1984 Olympics

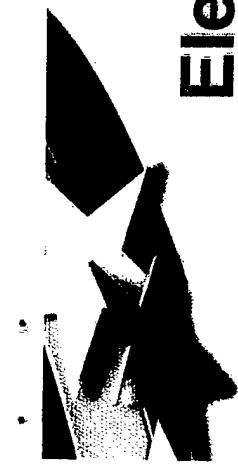


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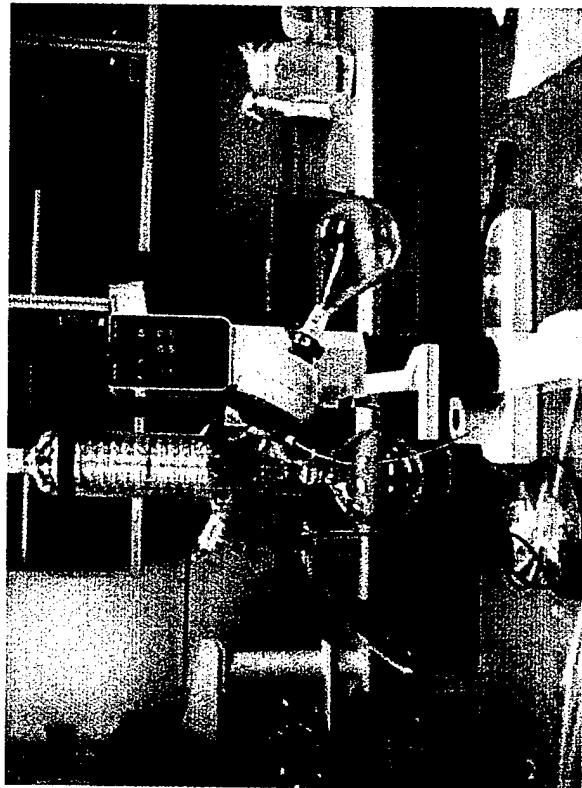
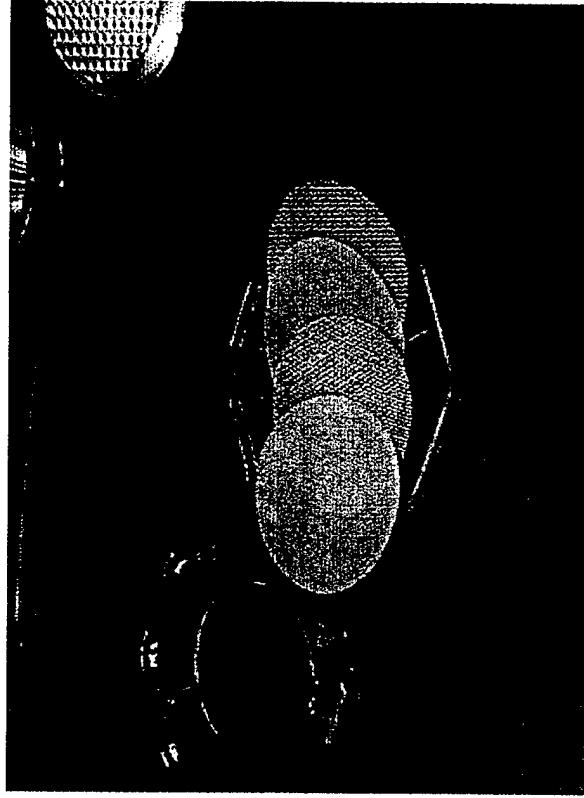
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Elements of Sandia's H₂O₂ Program



Sandia examined a variety of different catalyst materials and coating techniques.

Catalyst packs were developed in house at the ECF and AML

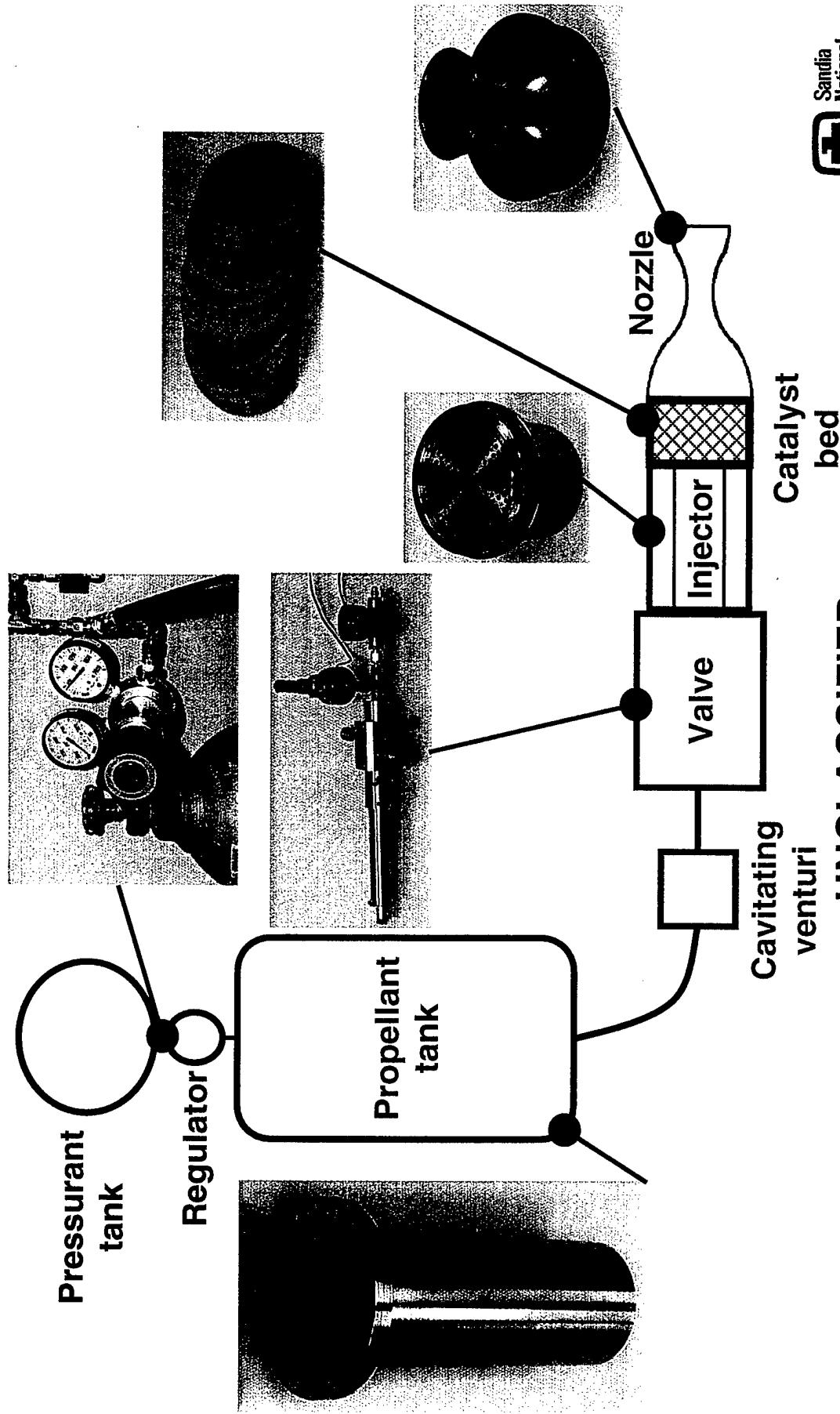


Hydrogen peroxide was not available in the high concentrations required. Sandia purchased hardware and developed processes to produce and handle >95% pure H₂O₂.

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Monopropellant Rocket Engine



National Laboratories

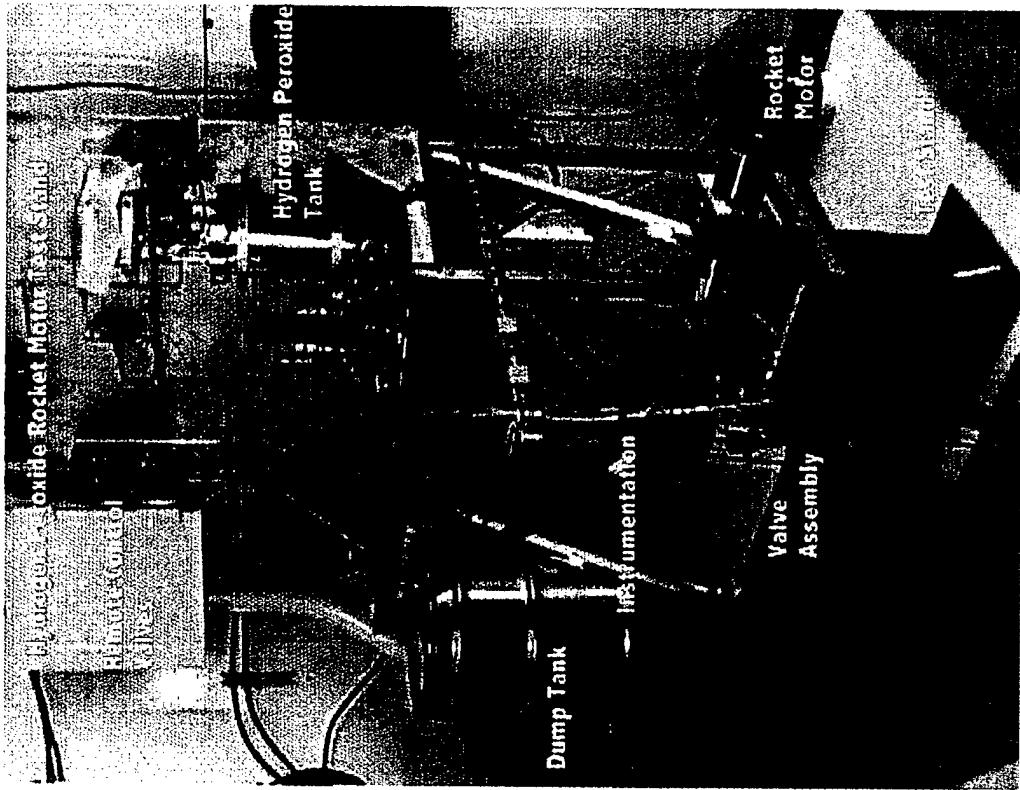
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H₂O₂ Test Setup

A control room and test cell were configured in the ECF to conduct the development tests.

This arrangement was used to perform several successful firings of the H₂O₂ development engine.

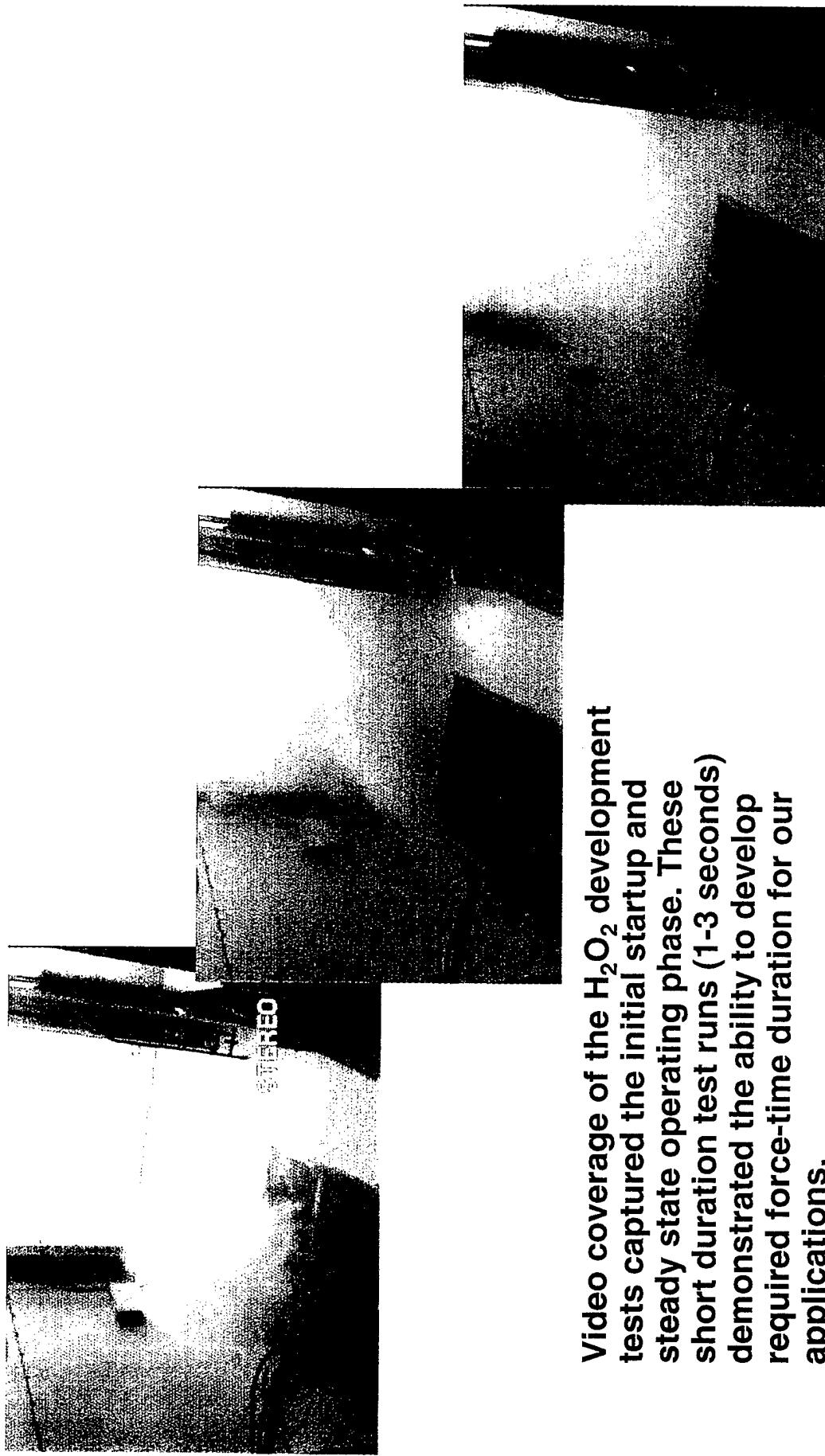


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Development Test Photos



Video coverage of the H_2O_2 development tests captured the initial startup and steady state operating phase. These short duration test runs (1-3 seconds) demonstrated the ability to develop required force-time duration for our applications.

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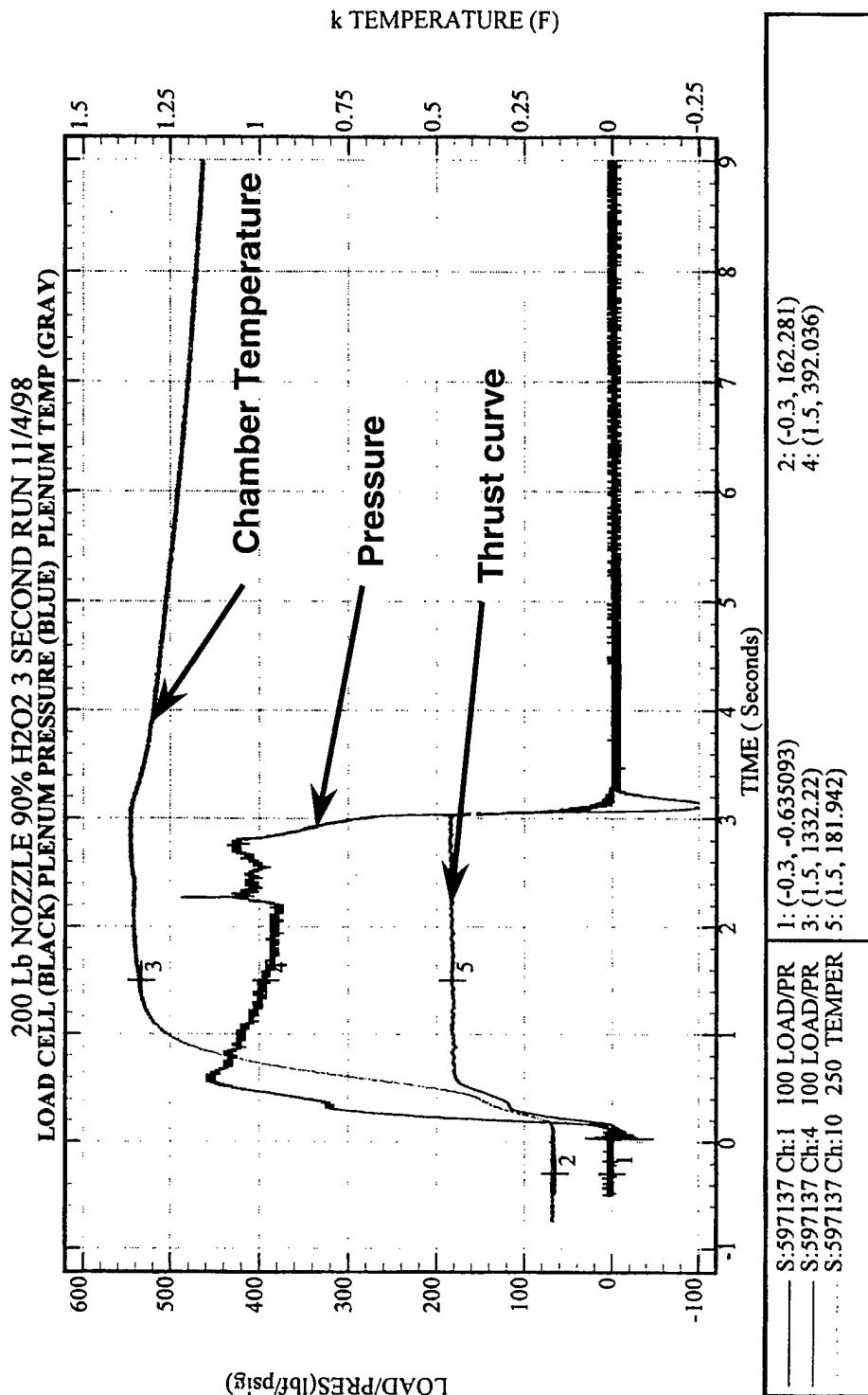


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H₂O₂ Development

Testing Results (12/98)

- Results from the recent development testing were very favorable
- Validated design and analysis predictions
- Demonstrated a capability to produce and handle concentrated H₂O₂
- Developed testing approaches, facilities and processes



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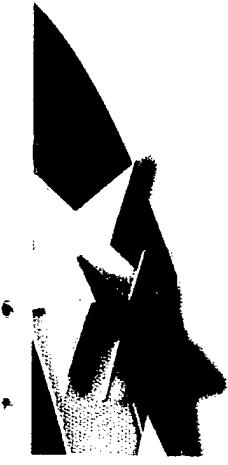
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Accomplishments

- Developed
 - safety procedures to handle material
 - hardware and process to distill 31% to 90+%
 - high speed control valve
 - catalyst pack
 - rocket engine
 - test stand

In house liquid propellant capability in 6 months!

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What did we learn?

- Simple vacuum distillation works well (liters/day)
- Clean / passivated hardware is imperative!
- Catalyst technology was somewhere between alchemy and sorcery
- Silver coatings on stainless steel screens work
- Solid silver screens work without Samarium Oxide coating
- High speed control valve works (20 ms response time)
- Semiconductor grade H₂O₂ material cleanest ever available
- All historical accidents attributable to organic contamination or gross mishandling

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The Future of Hydrogen Peroxide

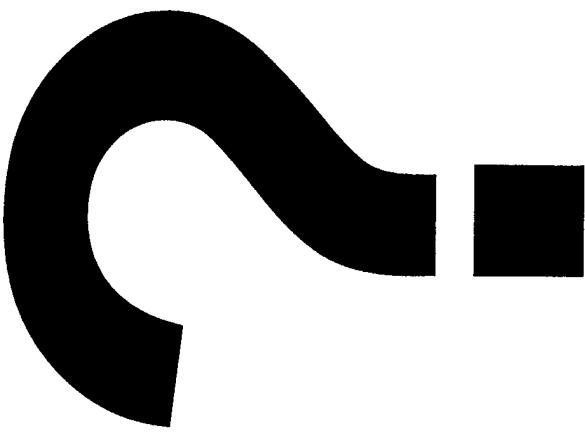
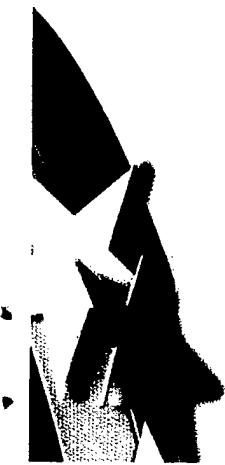
- Mars sample return mission
- Hydrazine replacement
(LM “Skunk Works” U2 gas generator)
- Chem/Bio agent decontamination
- Future Sandia flights
- SNL nanopropulsion

Use Your Imagination Now That
The Capability Exists Again!

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Discussion



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